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## DETECTING BUBBLES IN HONG KONG RESIDENTIAL PROPERTY MARKET

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### Abstract

This study uses a newly developed bubble detection method (Phillips, Shi and Yu, 2011) to identify real estate bubbles in the Hong Kong residential property market. Our empirical results reveal several positive bubbles in the Hong Kong residential property market, including one in 1995, a stronger one in 1997, another one in 2004, and a more recent one in 2008. In addition, the method identifies two negative bubbles in the data, one in 2000 and the other one in 2001. These empirical results continue to be valid for the mass segment and the luxury segment. However, the method finds a bubble in early 2011 in the overall market as well as in the mass segment but not in the luxury segment. This result suggests that the bubble in early 2011 in the Hong Kong real estate market came more strongly from the mass segment under the demand pressure from end-users of small-to-medium sized apartments.

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<p>The views and analysis expressed in this paper are those of the authors, and do not necessarily represent the views of the Hong Kong Monetary Authority.</p>
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## 1. INTRODUCTION

Over the last 15 years, both advanced economies and emerging economies have suffered from severe financial crises, including the Asian financial crisis, the Dot-Com crisis, the global financial crisis and the European debt crisis. All these crises were triggered by the collapse of price bubbles in asset markets, such as foreign exchange markets, equity markets and property markets. Not surprisingly, the former vice chairman of the U.S. Federal Reserve Board, Donald Kohn, argued that “Federal Reserve policymakers should deepen their understanding about how to combat speculative bubbles to reduce the chances of another financial crisis”. Given the adverse effects of these bubbles and the associated crises, economists and policymakers have been searching for ways to detect bubble formation empirically in order to take appropriate measures to deflate bubbles before they burst.

Bubble detection has been extensively studied in the literature. Perhaps the most commonly used detection methods are developed upon the present value model and the rational bubble assumption. The present value model states that the price of an asset is the sum of all its discounted future incomes in the absence of bubble condition. Blanchard and Watson (1982) showed that by solving consumers' optimization problem and assuming no rational bubble and no-arbitrage, the price of a financial asset (e.g. the price of a housing property) is the present value of the future incomes (e.g. the future rental income stream); see also Gurkaynak (2008) for an overview of the literature. This is often referred to as the fundamental part of the price of an asset. Rational bubbles arise when investors are willing to pay more than the fundamental value to buy an asset because they expect that the asset price will significantly exceed its fundamental value in the future. When rational bubbles are present, the asset price is composed of the fundamental component and the bubble component.<sup>1</sup>

An earlier method of detecting rational bubbles is the variance bounds test proposed by Shiller (1981). The idea is that, if a rational bubble exists, the variance of observed asset price will exceed the bound imposed by the variance of the fundamental value. However, this test is strongly criticized for having little structure on the bubble part and the indication of bubbles from the test could be ruled out by other reasonable factors. Another earlier method is the two-step test proposed by West (1987) which requires a detailed specification of an underlying equilibrium model of asset prices. Basically, the test compares the respective estimates of the impact of fundamental on the asset price in the underlying equilibrium model

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<sup>1</sup> From a theoretical perspective, the “bubble” explanation of the housing price dynamics is not satisfactory, as argued by Montrucchio and Privileggi (2001) and Leung (2004). Furthermore, from an empirical perspective, it may be difficult to differentiate the bubble dynamics from the dynamics generated by the regime switching process; see Chen (2001), Chang et al (2011a, b), and Driffill and Sola (1998).

and in a simple linear model that assumes no bubble component. If the estimate from the linear model is similar to that of underlying equilibrium model, it suggests no bubble. The discrepancy between the two estimates may suggest the presence of a bubble component. However, the power of this test is affected by how good the equilibrium model is and the rejection of the no bubble hypothesis may be due to the model misspecification rather than the existence of bubbles.

To deal with the deficiencies in the variance bounds test and in the two-steps test of West, Campbell and Shiller (1987) propose an alternative method which is based on the idea that the gap between the asset price and the fundamental value will exhibit explosive behavior during a bubble-formation process. In particular, Campbell and Shiller (1987) put forward to a unit root test in the first step to test the explosiveness and the presence of a bubble. If there is a bubble, the asset price and the fundamental value can be characterized by two possible cases.<sup>2</sup> In case one, the asset price is non-stationary but the fundamental value is stationary. In case two, both the asset price and fundamental value are non-stationary. However, the second case is not a piece of firm evidence for the presence of a bubble, and hence calls for a co-integration test in the second step. If a bubble is present, the asset price and its associated fundamental value cannot be co-integrated. Diba and Grossman (1988) further pointed out, the explosiveness in the gap between the asset price and the fundamental price is sufficient to the bubble detection and the unit root and co-integration tests are the tools for the identification of the explosiveness. Since then, the right-tailed unit root tests and the co-integration tests on the price series and fundamental value series have been widely used for detecting asset bubbles.

The unit root and co-integration tests have been applied to detect property market bubbles in different economies over the last two decades. For example, Drake (1993) used this method to study the price boom in the mid of 1980s in the UK property market and Arshanapalli and Nelson (2008) employed the co-integration test to identify the housing bubble in the mid of 2000s in the US housing market. For Hong Kong real estate market, Peng (2002) used this method to detect the 1997 bubble in the residential property market. The test has also

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<sup>2</sup> There are four possible scenarios when a unit root test is applied to the asset price and the fundamental value series: (A) the asset price and the fundamental value are both stationary; (B) the asset price is stationary but the fundamental value is non-stationary; (C) the asset price is non-stationary and the fundamental value is stationary; (D) the asset price and the fundamental value are both non-stationary. Scenario (A) indicates no bubble; Scenario (B) is not compatible with the rational bubble model; Scenario (C) suggests the presence of bubbles in the asset price; and Scenario (D) suggests that a co-integration test is needed to detect a co-integrated relation between the asset price and the fundamental.

been extended in different ways over time, such as using panel data and regime switching techniques.<sup>3</sup>

Although the unit root and co-integration tests have been widely used in empirical research, there is a serious limitation with the methodology pointed out by Evans (1991) who demonstrated that the unit root and co-integration tests are not capable of detecting explosive bubbles when there are periodically collapsing bubbles in the sample (Blanchard, 1979). Collapse breaks nonlinearity in the dynamic structure and substantially decreases the power of the test. Using simulated data, Evans (1991) examined the power of the unit root and co-integration tests and confirmed his argument. In a mildly explosive process with a collapse, Phillips and Yu (2009) showed that the DF statistics diverge to minus infinity when they are obtained from the full sample. This is why the standard unit root and co-integration tests fail to detect the explosiveness in the data covering the sample period where bubbles collapse. To deal with the Evans critique, a number of a number of methods have been recently proposed that have some power in detecting periodically collapsing bubbles.

The approach adopted in Phillips, Wu and Yu (PWY, hereafter, 2011) uses a sup Dickey-Fuller (DF) test (or forward recursive right-tailed DF test).<sup>4</sup> PWY suggested implementing the right-tailed DF test repeatedly on a forward expanding sample sequence and performing inference based on the sup value of the corresponding DF statistic sequence. They show that the sup DF (SADF) test significantly improves power compared with the conventional unit root and co-integration tests. As an additional advantage relative to the conventional unit root and co-integration tests, the method also provides estimates of the origination date and the termination date of a bubble. When there is a single bubble in the data, it is known that this dating strategy is consistent, as shown by Phillips and Yu (2009).

Testing procedures which are designed to test for structural breaks, such as Chow tests, model selection, and CUSUM tests may also be used to estimate the origination date and the termination date of a bubble. Extensive simulations conducted by Hogg and Breitung (2012) indicate that the PWY procedure works satisfactorily against other recursive (as distinct from full sample) procedures for structural breaks and is particularly effective as a real time bubble detection algorithm.

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<sup>3</sup> For example, based on the panel unit root and co-integration tests, Mikhed and Zemcik (2009) used US metropolitan data and Tsai and Peng (2011) used data of four major cities in Taiwan to detect property bubbles.

<sup>4</sup> PWY method can be used in connection to any other unit root tests.

A limitation in the PWY methodology is that it is designed to analyze a single bubble episode. Phillips, Shi and Yu (PSY, hereafter, 2011) show that if there are two bubbles in a time series and the duration of the second bubble is less than that of the first one, the PWY procedure cannot consistently estimate the origination date and the termination date of the bubble. This observation also applies to the case of multiple bubbles. Although many interest datasets in economics and finance involve only one bubble, the phenomenon of multiple bubbles is inevitable if one examines a long enough time series.

To overcome this weakness in PWY, PSY (2011) proposed an alternative approach named the supsup DF test, which is also based on the idea of repeatedly implementing a right-tailed DF test.<sup>5</sup> However, rather than fixing the starting point of each regression window to be the first observation of the full sample, the PSY procedure extends the sample sequence by varying both the starting point and the ending point of the sample over a feasible range of flexible windows. Comparing with the PWY procedure, the PSY procedure covers more subsamples of the data and has greater flexibility in choosing a subsample that contains a bubble episode. It was shown in PSY that their estimates of the origination date and the termination date of all the bubbles are consistent.

The objective of this study is to use the PSY method to identify asset price bubbles in the Hong Kong residential property market. Hong Kong's property market is of our interest because it is one of the most volatile real estate markets in the world and has experienced a few interesting episodes over the last 20 years. For example, there was a significant rise in price in 1997. In more recent years since mid-2009, there was another significant rise in price and hence it is important, from the policy perspective, to see if there is a bubble in the recent period.

This paper is arranged as follows. Section 2 explains the PSY method. In Section 3 talks about the Hong Kong residential property market. In Section 4 we report the empirical results. Finally, we provide a conclusion in Section 5.

## **2. PHILLIPS, SHI AND YU (PSY) METHOD**

Based on the present value model, rational bubble assumption and nonlinear explosive characteristic, PWY (2011) and PSY (2011) devise a procedure to identify the

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<sup>5</sup> PSY method can be used in connection to any other unit root tests.

bubble-type behavior in asset prices in subsamples with a flexible initial observation as well as a flexible window size. In the context of DF test, the method is based on the follow regression:

$$\Delta f_t = \mu + (\rho - 1)f_{t-1} + \varepsilon_t \quad (1)$$

where  $f_t$  is the time series of the asset price (in the present paper it is the ratio of real price and the real rent), and  $\varepsilon_t$  is the error term. In the test, the null hypothesis is  $H_0: \rho = 1$  (unit root behavior) and the alternative hypothesis is  $H_1: \rho > 1$  (explosive behavior). Different from the standard left-tailed unit root test where the alternative hypothesis is stationary, both the PSY test and the PWY test, looks directly for evidence of nonlinear explosive behaviour.

The innovation in the PWY method is that it calculates the right-tailed DF statistics in forward recursive regressions, that is, the initial observation of each regression is fixed to be the first observation of the full sample but the number of observations used in each regression expands until the full sample is utilized. The DF statistic is computed recursively from each regression and the sup DF statistic is then used to detect the presence of bubble. In order to identify the origination and collapse dates of a bubble, the recursive DF statistic can be matched against the critical value sequence. In particular, the first recursion uses  $\tau_0 = [nr_0]$  observations, for some fraction  $r_0 \in (0,1)$  as an initial period. Subsequent recursions employ this initial data set supplemented by successive observations giving a sample size of  $\tau = [nr]$  for  $r_0 \leq r \leq 1$ . The origination of a bubble is dated as the first recursion for which the value of the DF statistic of estimated  $\rho$  is equal to or larger than the right side critical value, and the collapse date is identified as the first subsequent recursion for which the DF statistic drops back to or below the critical value. PWY obtained the asymptotic distribution of the sup DF statistic under the null hypothesis. Under a particular specification in the alternative hypothesis where a bubble developed and crashes in the sample, Phillips and Yu (2009) showed that the dating mechanism is consistent.

A limitation in the PWY method is that while it is effective when there is only one bubble in the sample and also effective to time stamp the first bubble when there are multiple bubbles in the sample, they are less useful to time stamp the subsequent bubbles, as shown in PSY (2011). On the other hand, the economists and policy makers are often interested in knowing whether or not there are subsequent bubbles in the sample, and if so, how to estimate the origination date and the collapse date of the subsequent bubbles. To time stamp the subsequent bubbles, in the context of DF test, the PSY method is also based on the regression model (1),



testing  $H_0 : \rho = 1$  against  $H_1 : \rho > 1$ . However, it calculates the right-tailed DF statistics in more flexible recursive regressions, not only varying the number of observations but also varying the initial observation of each regression. The supsup DF statistic is then used to detect the presence of bubbles. In order to identify the origination and collapse dates of a bubble, the sup DF statistic, where the supremum is taken with respect to the number of observation but the last observation is anchored, can be matched against the critical value.

In particular, suppose the minimum number of observation used in any regression is  $\tau_0 = \lfloor nr_0 \rfloor$ , for some fraction  $r_0 \in (0,1)$ . Suppose a regression sample starts from the  $r_1^{th}$  fraction of the total sample and ends at the  $r_2^{th}$  fraction of the sample, where  $r_2 = r_1 + r_w$  and  $r_w \in [r_0, r_2 - r_0]$  is the (fractional) window size of the regression. The number of observations in the regression is  $n_w = \lfloor nr_w \rfloor$  where  $\lfloor \cdot \rfloor$  represents the integer part. Let the DF statistic from this regression be  $DF_{r_2 - r_w}^{r_2}$ . The supsup DF statistic is obtained by taking the supremum twice with respect to  $r_w$  and  $r_2$  where  $r_2 \in [r_0, 1]$ ,  $r_w \in [r_0, r_2 - r_0]$ . PSY obtained the asymptotic distribution of the supsup DF statistic and reported the quantiles of the asymptotic distribution (and hence critical values of the test). For example, if the coefficient-based test statistic is obtained from the regression model (1), i.e.

$$DF_{r_2 - r_w}^{r_2} = \lfloor nr_w \rfloor (\hat{\rho} - 1), \quad (2)$$

then the supsup coefficient-based DF statistic is

$$\sup \sup DF = \sup_{r_w} \sup_{r_2} DF_{r_2 - r_w}^{r_2}. \quad (3)$$

The limit distribution of the supsup coefficient-based DF statistic is

$$\sup_{r_w} \sup_{r_2} \frac{\frac{1}{2} r_w [B^2(r_2) - B^2(r_1) - r_w] - \int_{r_1}^{r_2} B(r) dr [B(r_2) - B(r_1)]}{r_w \left\{ r_w \int_{r_1}^{r_2} B^2(r) dr - \left[ \int_{r_1}^{r_2} B(r) dr \right]^2 \right\}}, \quad (4)$$

where  $B(r)$  is a standard Brownian motion. PSY obtained the critical value of asymptotic distribution of the supsup DF t statistic and reported them in their Table 1. The critical value of asymptotic distribution (4) can be obtained in the same way and will be reported later.

To time stamp the origination and the conclusion of all the bubbles, PSY suggested calculating a sup DF statistic based backward expanding samples at any point between  $r_0$  and 1. In particular, we fix the ending point of the samples at  $r_2 \in [r_0, 1]$  but let the starting point varies from 0 to  $r_2 - r_0$ . Let the DF statistic for this regression be  $DF_{r_1}^{r_2}$  and the sup DF statistic be  $BSDF_{r_2}(r_0) = \sup_{r_1 \in [0, r_2 - r_0]} DF_{r_1}^{r_2}$ . This statistic is matched against the critical value obtained from the asymptotic distribution of the sup DF statistic under the null hypothesis because this procedure of identifying the origination and the conclusion of a bubble is identical to what PWY suggested for detecting the presence of a bubble in the full sample. Suppose  $CV_{r_2}$  is the critical value, then the origination and the collapse date of a bubble are estimated, respectively, by

$$\hat{r}_e = \inf_{r_2 \in [r_0, 1]} \{r_2 \mid BSDF_{r_2}(r_0) > CV_{r_2}\},$$

$$\hat{r}_f = \inf_{r_2 \in [\hat{r}_e, 1]} \{r_2 \mid BSDF_{r_2}(r_0) < CV_{r_2}\}.$$

The origination date is the first chronological observation whose backward DF statistic  $\hat{r}_e$  exceeds the critical value and the collapse date is the first chronological observation after the origination date whose backward DF statistics  $\hat{r}_f$  goes below the critical value. If  $CV_{r_2} \rightarrow \infty$ , under the null hypothesis of no bubbles, the probabilities of (falsely) detecting the origination of bubble expansion and the termination of bubble collapse using this method tend to zero; see PSY for details. In this paper, we simply choose  $CV_{r_2} = 1.66 + \log(r_2 n)/100$  where 1.66 is the 90 percentile of the asymptotic distribution of the sup DF statistic obtained by us via simulations.<sup>6</sup> The term  $\log(r_2 n)/100$  is used to make  $CV_{r_2} \rightarrow \infty$  slowly.

Although only positive bubbles have been emphasized in the literature, bubbles can be negative too. In this case, the fundamental value is less than the observed price and the

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<sup>6</sup> If the DF t statistic is used, PSY obtained the critical values at 1%, 5% and 10%; see Table 1 in PSY (2011).

observed price drifts downwards explosively. The PSY method can be used in the same way to identify negative bubbles.

**Figure 1: Real price index of Hong Kong residential property market  
(March 1993 to March 2011, 1999=100)**



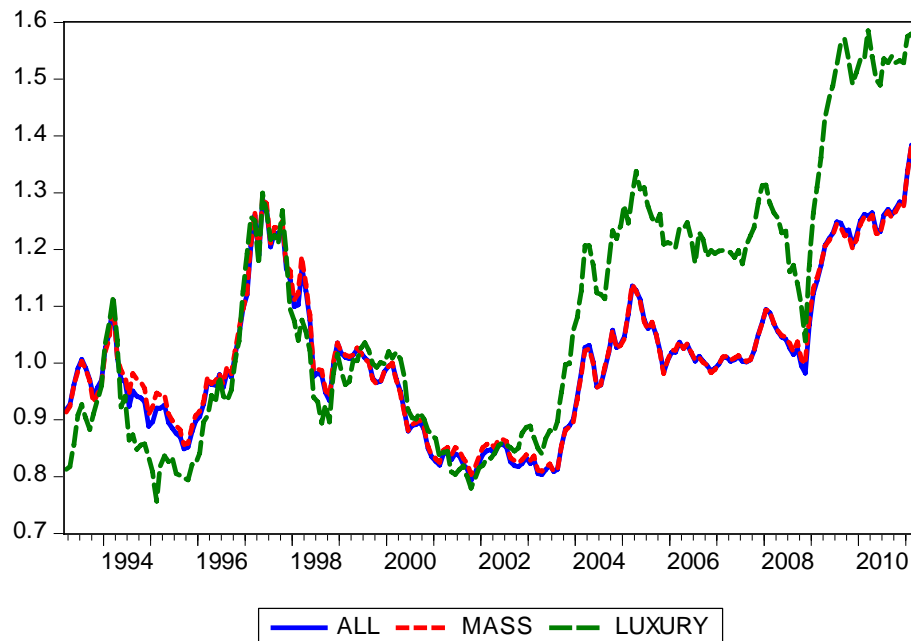
Source: Rating and Valuation Department and Census and Statistics Department of HKSAR

### 3. HONG KONG RESIDENTIAL PROPERTY MARKET

Figure 1 display the time series plot of monthly real price index of Hong Kong residential property market, where real price index is defined as the nominal price index divided by the CPI. Data on housing price index and rent index is from the Rating and Valuation Department (R&VD) of Hong Kong SAR and data of CPI is from the Census and Statistics Department. As shown in Figure 1, the Hong Kong residential property market experienced a strong price up-movement in between end 1995 and early 1997. The exuberance was stopped several months later because of the Asian financial crisis in 1998. This downward movement in the real estate sector is associated with the price deflation, recession and feeble economic activities till 2003. In mid- and late-2008, the property market was severely hit by the global financial crisis and housing prices dropped considerably. However, since early 2009, the

recovered market sentiment and strong capital inflows boosted a robust rally in property prices which caused concern about risk of asset-bubble formation.<sup>7</sup>

**Figure 2: Price-rent ratio of  
Hong Kong residential property market  
(March 1993 to March 2011)**



Source: Rating and Valuation Department and Census and Statistics  
Department of HKSAR

Figure 2 depicts the price-rent (p-r) ratio of the overall Hong Kong residential property market as well as those of the mass and luxury segments.<sup>8</sup> The ratios as of March 2011 of both segments were higher than the peaks of those as of 1997, with a larger margin in

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<sup>7</sup> It is naturally to ask that, if capital inflows are the driving factor of the housing bubble, can the housing bubble period be interpreted as a period of time with “excess” capital inflows? Capital inflows can be viewed as a necessary condition of a housing bubble only, since capital inflows can go into other asset markets, e.g. Indonesia has been dealing with excess capital inflows into its sovereign debt market since 2009. Furthermore, because of its bounded territory, Hong Kong as well as Singapore is relative easier to face housing bubbles due to the expectation of limited supply of housing.

<sup>8</sup> The mass segment comprises of private domestic properties with saleable area less than 100m<sup>2</sup> (Classes A to C according to the R&VD classification); and the luxury segment comprises of private domestic properties with saleable area larger than 100m<sup>2</sup> (Classes D to E in the R&VD classification).

the luxury segment than in the mass market. Moreover, the dynamics in the luxury segment seems quite distinctly different from that in the mass market.

#### 4. EMPIRICAL RESULTS

In the present paper, we will apply the PSY method to the Hong Kong residential property market. Following the PSY (2011) who tested the explosive behavior in the price-dividend ratio of the S&P500 stock price index, we test the explosive behavior in the ratio between the real property price index and real rent index of the Hong Kong residential property market. The p-r ratio measures the deviation of the price from its corresponding fundamental. The ratio is expected to have an explosive feature if an asset price bubble presents. Table 1 reports the summary statistics of the p-r ratio, including the mean, variance, skewness, kurtosis, the autocorrelation coefficients at different lags, and the DF-t statistic obtained from the full sample. Obviously, the time series is very persistent. Under the null hypothesis of unit root, the 5 percentile and the 95 percentile of the asymptotic distribution of the DF-t statistic are -3.12 and -0.07 respectively. As the DF-t statistic from the data is -0.967, falling within the range of the 5 percentile and the 95 percentile, we would not be able to find the evidence of explosive behavior in the full sample.

**Table 1: Summary statistics for the overall market between March 1993 and December 1998**

Mean	variance	skewness	kurtosis	rho1	rho2	rho5	rho10	DF-t
1.01	1.384	0.580	2.732	0.960	0.911	0.788	0.584	-0.967

##### 4.1 Detection of Bubbles

First, we apply the PSY method on the p-r ratio of the overall market and also the mass and luxury segments from March 1993 to March 2011. Table 1 reports the supsup DF statistic in all three cases with  $\tau_0 = 11$ , that is, a minimum of 11 observations are used in each regression. Also reported are the 10%, 5% and 1% critical values of the supsup DF statistic under the null hypothesis. In all three cases, the test statistics are much larger than the 1% critical value, suggesting overwhelming evidence of bubbles in these three markets. Interestingly, the test statistic for the luxury segment is the lowest, although the largest margin between the price and

the rent was observed in the luxury segment. This occurs because our test statistic depends on the dynamic properties of the data, not the level.

**Table 2:  $\sup \sup DF$  statistic for the overall market and the two segments**

	Overall Market	Mass Market	Luxury Market
$\sup \sup DF$	8.4374	7.8108	7.6805
10% CV	2.3750	2.3750	2.3750
5% CV	2.9023	2.9023	2.9023
1% CV	3.9997	3.9997	3.9997

#### 4.2 Time Stamping Bubbles in the Overall Market

To locate specific bubble periods in the overall market, we compare the BSDF statistics with a critical sequence. Figure 3 plots the  $BSDF_{r_2}(r_0)$  statistics against  $CV_{r_2} = 1.66 + \log(r_2 n)/100$  for the overall market. The vertical lines and shaded areas are for the identified bubbles. In total, the PSY method has found 10 bubbles. The identified periods with a positive or negative bubble include 1994M01-M02, 1995M08-M12, 1997M02-M05, 1999M12-2000M02, 2000M06, 2000M11-2001M03, 2004M10, 2007M10-2008M04, 2009M01 and 2011M01. Among these bubble episodes, two periods involve negative bubbles, namely, 2000M06 and 2000M11-2001M03. The largest  $BSDF_{r_2}(r_0)$ , when there is a positive bubble, occurred in January 2008, with a value of 5.985. The size of the bubble in 1997 is similar with the test statistic of 5.675.

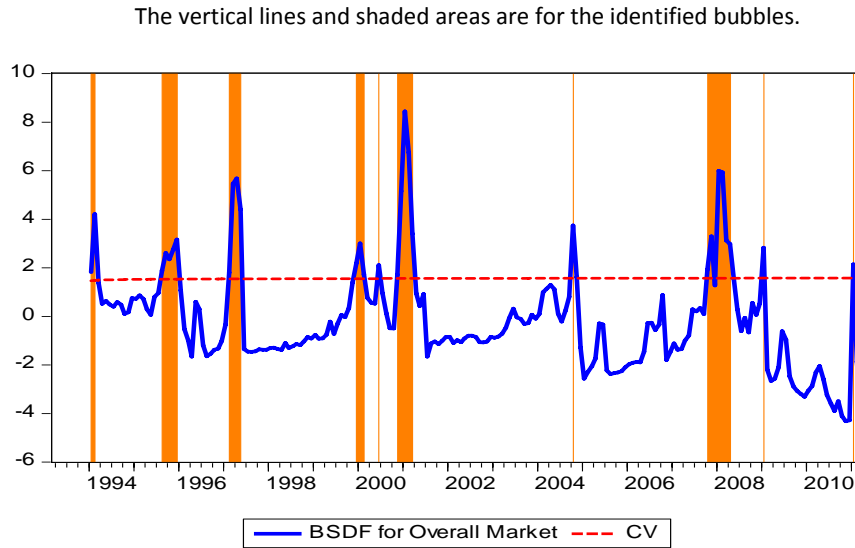
Several interesting empirical conclusion can be made for the overall market. First, the much-talk-about bubble in 1997 in the Hong Kong real estate market (see Kalra et al., 2000 and Peng, 2002 for the speculative bubble in the Hong Kong property market in 1997) is confirmed by our study. The bubble lasted for 4 months between February and May 2007 and the statistic was much above the critical value. However, a bubble in the late 1995 has not been discovered in the literature. Second, after the effect of SARS diminished in 2004, we identify another positive bubble in October 2004 which was shorter lived. A somewhat longer-lived bubble occurs in the end of 1997 and early 2008. Finally, our method identifies a bubble in December 2008 and another one in January 2011. However, the bubble in January 2011 did not

last for long, perhaps because the macro-prudential policies introduced by the SAR government,<sup>9</sup> as a way to control the real estate bubbles, changed the dynamics in the price movement.

#### 4.2 Time Stamping Bubbles in the Two Segments

To check how robust of the bubble periods in the overall market, we then apply the PSY method to locate specific bubble periods in the mass segment and in the luxury segment. Figure 4 plots the  $BSDF_{r_2}(r_0)$  statistics against  $CV_{r_2} = 1.66 + \log(r_2 n)/100$  for the mass segment while Figure 5 is for the luxury segment.

**Figure 3:  $BSDF_{r_2}(r_0)$  statistics for the overall Hong Kong residential property market (March 1993 to December 1998)**

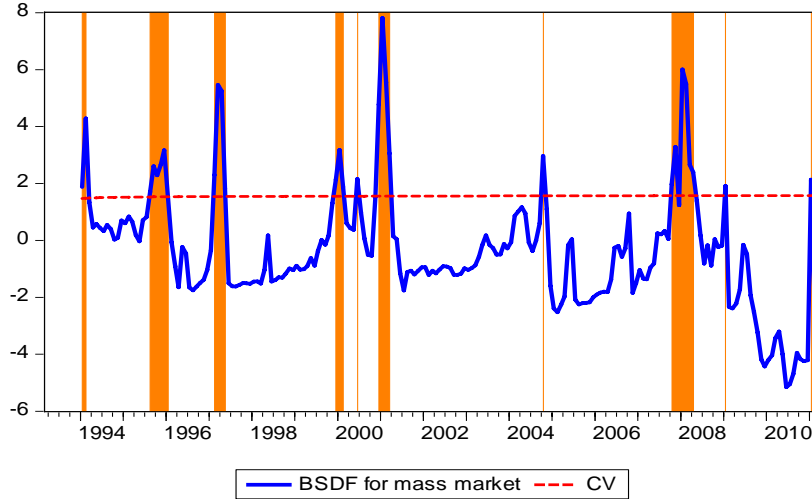


The identified periods in the mass market with a bubble include 1994M01-M02, 1995M08-M12, 1997M02-M05, 1999M12-2000M02, 2000M06, 2000M12-2001M03, 2004M10, 2007M10-2008M04, 2009M01 and 2011M01. Among these bubble episodes, two periods involve negative bubbles, namely, 2000M06 and 2000M12-2001M03. All the empirical results are almost identical to those for the overall market.

**Figure 4:  $BSDF_{r_2}(r_0)$  statistics for the mass segment (March 1993 to December 1998)**

<sup>9</sup> For details, see the Appendix.

The vertical lines and shaded areas are for the identified bubbles.



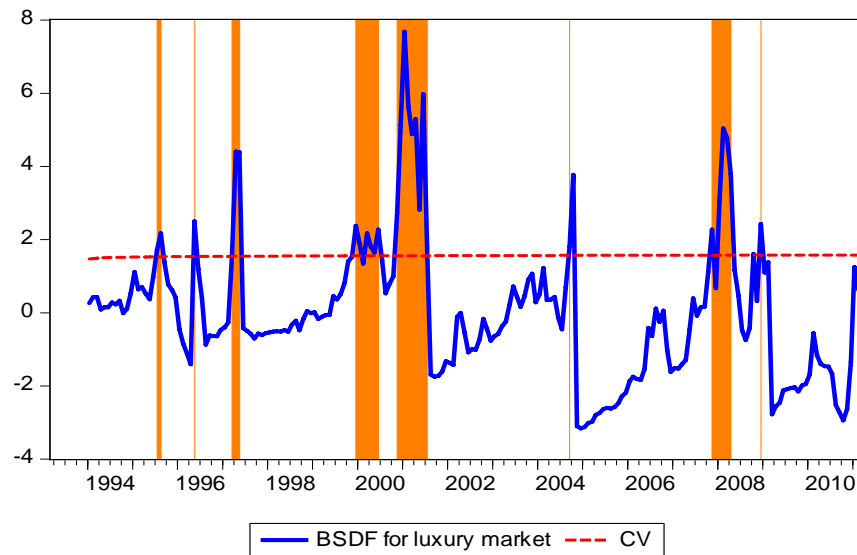
The identified periods in the luxury market with a bubble include 1995M07-M08, 1996M05, 1997M04-M05, 1999M12-2000M06, 2000M11-2001M07, 2004M09-M10, 2007M11-2008M04, and 2008M11. Among these bubble episodes, two periods involve negative bubbles, namely, 2000M11-2001M07 and 2008M11. The two bubbles found 1994 and 2011 in the overall market and the mass segment cannot be found in the luxury segment. The lack of strong evidence of speculative bubbles in the luxury market in the post global financial crisis period may due to the series of prudential measures imposed by the Hong Kong SAR Government to curb speculative activities and to safeguard financial stability of the banking sector. The Appendix lists the prudential measures imposed since October 2009. The earlier ones, such as the reduction of loan-to-value ratio in mortgage loans in October 2009 and the increase of Stamp Duty in April 2010, were particular strenuous on luxury apartments. However, these prudential measures did not fully mitigate the demand pressure from the end-users, the main purchasers in the mass market, given their expectation of very limited supply of new apartments in the near to medium terms and the continuation of the low mortgage rate conditions.

**Figure 5:  $BSDF_{r_2}(r_0)$  statistics for the luxury segment**

**(March 1993 to December 1998)**

The vertical lines and shaded areas are for the identified bubbles.





## 5. CONCLUSION

We have applied the newly developed PSY method to identifying asset price bubbles in the Hong Kong residential property market. The method identifies the well known real estate bubble in 1997. In addition, it identifies nine other bubbles between 1994 and 2011, including two periods with a negative bubble. In the pre and post 2008 global financial crisis periods, the PSY method is able to detect two positive bubbles in the overall market and the mass segment, one in early 2008 and another one in 2011. However, both bubbles are very short lived. For the luxury segment we cannot identify any positive bubble in 2011. These results suggest that the recent bubble in the Hong Kong real estate market comes more strongly from the mass segment under the demand pressure of end-users and the imposition of various macro-prudential policies by the SAR governments were perhaps effective in changing the dynamics of the price movement, particularly in the luxury segment.

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**Appendix: Macro-prudential Measures to Property Transactions and Mortgage Lending since 2009**

**1. Stamp Duty on sale of immovable property in Hong Kong increased in April 2010**

- For properties with a value below HK\$2 million, paying HK\$100;
- For properties with a value from HK\$2 million and below HK\$2.35 million, paying HK\$100 + 10% of excess over HK\$2 million;
- For properties with a value from HK\$2.35 million and below HK\$3 million, paying 1.5%;
- For properties with a value from HK\$3 million and below HK\$3.29 million, paying HK\$45,000 + 10% of excess over HK\$3 million;
- For properties with a value from HK\$3.29 million and below HK\$4 million, paying 2.25%;
- For properties with a value from HK\$4 million and below HK\$4.43 million, paying HK\$90,000 + 10% of excess over HK\$4 million;
- For properties with a value from HK\$4.43 million and below HK\$6 million, paying 3%;
- For properties with a value from HK\$6 million and below HK\$6.72 million, paying HK\$180,000 + 10% of excess over HK\$6 million;
- For properties with a value from HK\$6.72 million and below HK\$20 million, paying 3.75%;
- For properties with a value from HK\$20 million and below HK\$21.74 million, paying HK\$750,000 + 10% of excess over HK\$20 million;
- For properties with a value above HK\$21.74 million, paying 4.25%.

**2. Special Stamp Duty imposed on sale of immovable property in Hong Kong in November 2010**

- Imposing the SSD for residential property acquired on or after 20 November 2010 and resold with 24 months the following Stamp Duty in addition to the ad valorem rates of Stamp Duty already imposed before: 15% within 6 months, 10% between 6 months to 12 months and 5% between 12 months to 24 months.

**3. Prudential measures imposed on property mortgage in October 2009**

- Applying a maximum Loan-to-Value (LTV) ratio of 60% to properties with a value at HK\$20 million or above.

**4. Prudential measures imposed on property mortgage in August 2010**

- Applying a maximum LTV ratio of 60% to properties with a value at HK\$12 million or above;
- For properties valued below HK\$12 million, the 70% LTV will continue to apply, but the maximum loan amount is capped at HK\$7.2 million;
- Lowering the maximum LTV ratio for properties which are not intended to be occupied

by the owners to 60%.

**5. Prudential measures imposed on property mortgage in August 2010**

- Lowering the maximum LTV ratio for properties with a value at HK\$12 million or above from 60% to 50%;
- Lowering the maximum LTV ratio for properties with a value at or above HK\$8 million and below HK\$12 million from 70% to 60%, but the maximum loan amount is capped at HK\$6 million;
- Maintaining the maximum LTV ratio for residential properties with a value below HK\$8 million at 70%, but the maximum loan amount is capped at HK\$4.8 million;
- Lowering the maximum LTV ratio for all non-owner-occupied residential properties, properties held by a company and industrial and commercial properties to 50%, regardless of property values.

**6. Prudential measures imposed on property mortgage in June 2011**

- For owner-occupied residential properties with a value at HK\$10 million or above, the maximum Loan-to-Value (LTV) ratio shall be 50%;
- For owner-occupied residential properties with a value at HK\$7 million or above but below HK\$10 million, the maximum LTV ratio shall be 60%, subject to a maximum loan amount of HK\$5 million;
- For owner-occupied residential properties with a value below HK\$7 million, the maximum LTV ratio shall be 70%, subject to a maximum loan amount of HK\$4.2 million.
- Reducing the applicable maximum LTV ratio by 10 percentage points for all property mortgages to borrowers whose income is derived mainly from outside Hong Kong. However, borrowers who can demonstrate having a close connection with Hong Kong (e.g. those who are on secondment by a local employer to work outside Hong Kong with documentary proof provided by the employer or those who have their immediate family members residing in Hong Kong) will not be subject to the LTV reduction; and
- Lowering the maximum LTV ratio for residential and non-residential property mortgage loans based on borrowers' net worth (i.e. net worth-based mortgage loans) from 50% to 40% irrespective of the value of the properties. In view of the difficulties in verifying borrowers' net worth regularly, it is considered prudent to lower the maximum LTV ratio.